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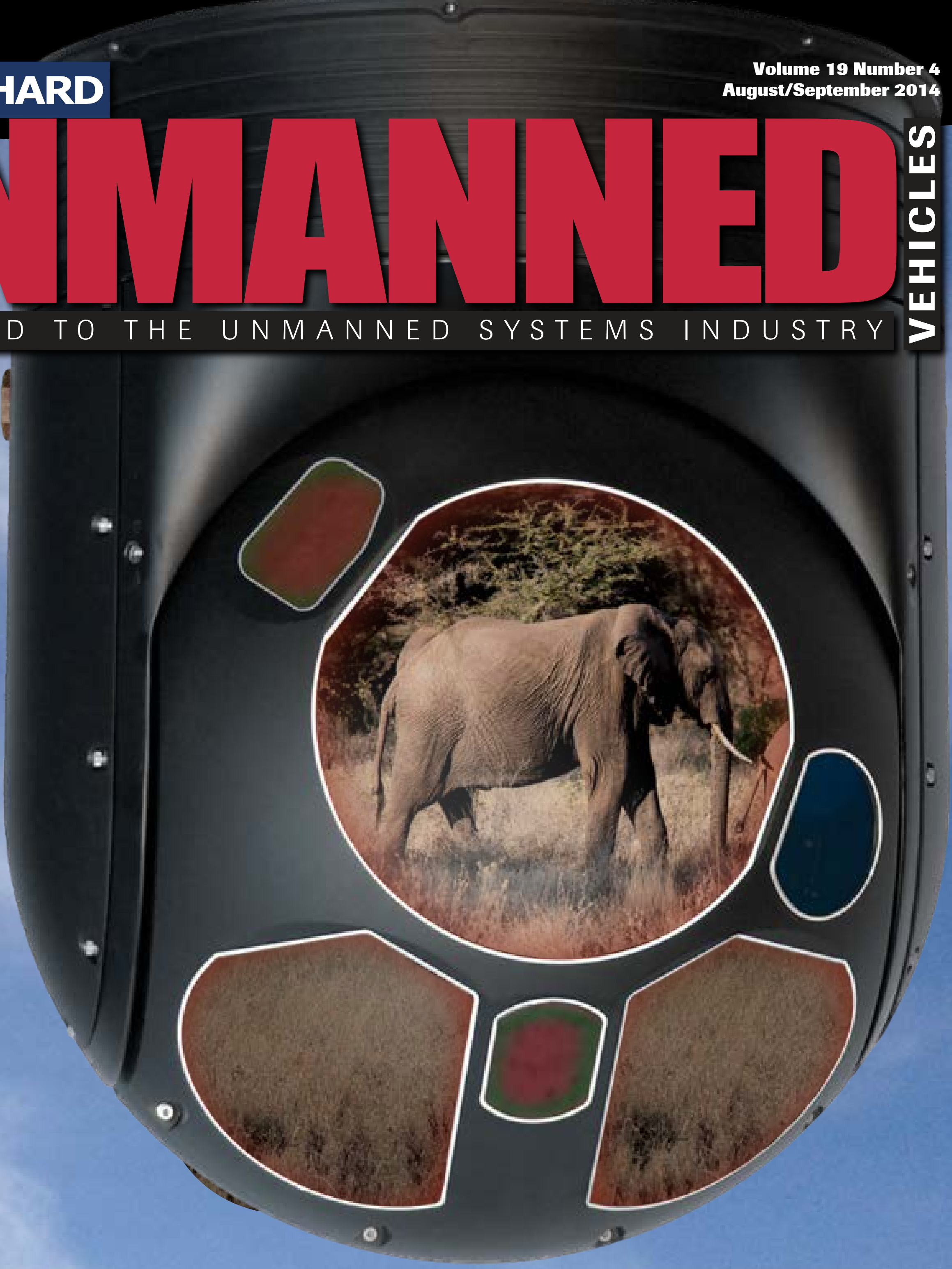

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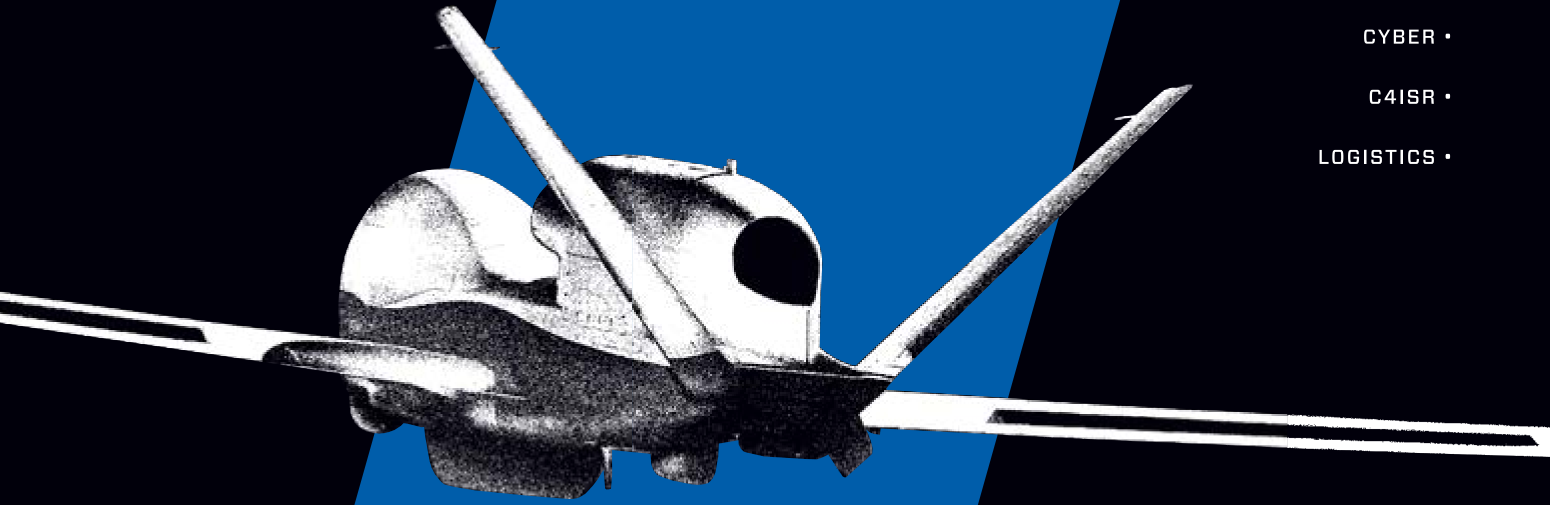

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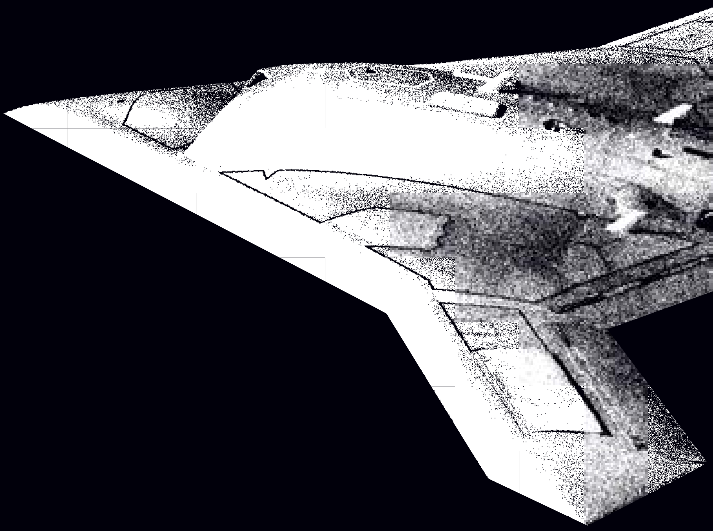

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Front cover: UAS technology could help combat poaching activity in Africa. *(Image: FLIR Systems/istockphoto/Lorna Francis)*

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Out of the spotlight?

As *Unmanned Vehicles* went to press, Israel and Hamas were entering a three-day ceasefire in Gaza following hostilities which started on 8 July. But rather unusually, we are not hearing much detail regarding the deployment of UAVs in the conflict.

It is no secret that the IDF lies marginally behind the US in terms of the development and deployment of mature unmanned systems, and it is undoubtable that it will have been utilising an array of such platforms to conduct ISR missions over the past few weeks.

Furthermore, it is highly likely Israel will have used these systems for precision strikes on Hamas positions in Gaza. However, the IDF has been unavailable to discuss the use of armed UAVs during this most recent conflict, although we know the capability is most certainly there.

Photographs have appeared on websites such as Twitter illustrating the first operational deployment of Elbit Systems' Hermes 900, as well as a Hermes 450 UAV with unknown payload bays under each wing. Speculation continues as to whether these pods were carrying fuel, EW sensors or attack munitions.

Meanwhile, Hamas claims to have captured a damaged Skylark UAV, traditionally used for 'over-the-hill' surveillance by the IDF and certainly not designed for direct action.

On the other side, the IDF's official Twitter account claimed to have shot down an 'aerial drone from Gaza' which infiltrated Israeli territory in July. The platform was hit by a Patriot missile, it is understood.

Naturally, the IDF's discretion in commenting on the use of UAVs throughout Operations *Brother's Keeper* and *Protective Edge* is hardly surprising, but the most noticeable aspect is that we are not witnessing the worldwide condemnation of drone strikes. This, to my mind, marks a significant first considering coverage of recent campaigns in Afghanistan and Iraq, not to mention cross-border operations in Pakistan and Yemen, where criticism of Predator and Reaper strikes has been widespread.

With the frequency of IDF artillery and air strikes hitting Gaza, it strikes me as rather surprising that international news outlets have refrained from blaming drones for any collateral damage caused. This lack of criticism appears even more peculiar when one considers the close-knit relationship enjoyed by Washington and Tel Aviv, a case in point being the recent decision to pump an additional $200 million into the IDF's fabled Iron Dome C-RAM system.

Questions that spring to mind are: does this lack of attention display a growing tolerance of the utility of UAVs, whether armed or not? Are observers too concerned with other aspects of the fighting to focus on the use of UAVs? Has the IDF tied down covert operation of such systems or, is it managing to successfully cloak any details from the public?

Regular critics such as Amnesty International and Code Pink have remained relatively quiet on this front, with Drone Wars UK only managing to remark [at the Farnborough International Airshow]: 'IAI certainly seemed in no way abashed to declare that its Searcher, Heron and Eitan drones were "fully operational with the Israeli Air Force" during the week despite the horror and revulsion many feel at the horrific loss of life and damage to the civilian infrastructure.'

The utility of unmanned systems stretches far beyond kinetic operations, and it will be interesting to hear the response of drone critics when similar hardware is used for humanitarian aid/disaster-relief operations, potentially in Gaza as well.

Andrew White, Editor

RESPONSE

Unmanned Vehicles' editorial team is always happy to receive comments on its articles and to hear readers' views on the issues raised in the magazine. Contact details can be found on p1.

IN THE NEXT ISSUE

- MCM
- Tactical UAVs
- Small UGVs
- Propulsion

UCAV programmes make progress

This year's Farnborough International Airshow provided a timely opportunity for interested parties in Europe, the UK and the US to provide updates on the progress of their various UCAV programmes.

As *Unmanned Vehicles* went to press, the US DoD was expecting to release the final RfP for its Unmanned Carrier Launched Airborne Surveillance and Strike (UCLASS) programme 'within weeks', according to the USN's Program Executive Officer for Unmanned Aviation and Strike Weapons, RAdm Mat Winter.

However, speaking to the media on 14 July, Winter said the RfP would not be released until the 'correct design requirements' had been agreed across the board. The document will be addressed to four bidding vendors – Boeing, General Atomics Aeronautical Systems, Lockheed Martin and Northrop Grumman.

An RfP had initially been promised in September 2013, with the four vendors winning preliminary design review contracts for the air vehicle in August the same year. Following publication of the final RfP, vendors will have 60 days to provide their responses ahead of a final source selection. A decision is expected to take approximately ten months, Winter added.

'We will identify a single vendor to bring to the senior leadership for the downselect contract for the air segment [of the UCLASS programme]. We envision a contract award for the air vehicle segment in the second to third quarter of FY2015.'

STEALTH CAPABILITY

Meanwhile, BAE Systems released further details regarding its Taranis UCAV demonstrator, which successfully proved its stealth capability in a second phase of testing.

According to programme officials, the aircraft conducted its latest round of flight trials at an undisclosed location between the end of 2013 and the start of 2014, proving 'communications, mission performance and aircraft handling in low observability'. Chris Garside, engineering director, future combat air systems, at BAE Systems, described a 'major technological breakthrough… in full stealth configuration'.

Photo: BAE Systems

'We demonstrated a conformal air data system, generating a full set of flight data without an external boom which would have detracted from the LO [low observable] nature of the aircraft,' he explained. 'We fully validated design objectives set out at the beginning of the programme.'

The UK MoD is currently in discussions with BAE Systems regarding funding for an additional flight trials programme, although company executives were unable to comment on what they wanted to achieve in any further test phases.

One option, according to Garside, could see funds secured from the £120 million pot available from the Anglo-French Future Combat Air Systems (FCAS) programme.

'We are currently discussing opportunities with the MoD for further trials going forward. Negotiations we are currently engaged in are regarding FCAS funds,' he said, while admitting that Taranis and Europe's Neuron programme could both make important contribution to Anglo-French study efforts.

Referring to European collaboration on the Neuron UCAV demonstrator, Saab's VP for future products, Mats Palmberg, told *UV* that testing remained on track, with the air vehicle scheduled to transit from France to the Vidsel test range in Sweden next year.

Finally, Northrop Grumman informed *UV* that the USN's X-47B Unmanned Combat Air System-Demonstrator (UCAS-D) will deploy to sea on board the aircraft carrier USS *Theodore Roosevelt* in August.

Northrop Grumman's UCAS-D programme manager Pablo Gonzalez was unable to provide exact deployment dates, adding that 'ship schedules are classified', but confirmed that the deployment would be conducted in the August time frame.

The forthcoming deployment will demonstrate the collaboration of manned and unmanned aircraft on deck. 'This will provide an opportunity to collect more data and demonstrate a wider range of environmental conditions. We will collect that data as the opportunity presents itself and will be doing some operations in an expanded envelope to transition from shore to ship,' Gonzalez said.

Precise details of the deployment remain undisclosed due to operational security concerns. However, he confirmed that the tests would be conducted along the US Eastern seaboard.

Tests will also include manned-unmanned teaming with F/A-18s on board the *Theodore Roosevelt*, with Gonzalez explaining: 'The current body of work leading to the next deployment aboard the carrier has to do with getting the unmanned vehicle and manned vehicles competing nicely on deck during launch and recovery operations.'

By Andrew White, Farnborough

AeroVironment pioneers Alaskan UAV operations

AeroVironment and petroleum giant BP have signed a services agreement for the provision of UAV operations in Alaska, marking a significant milestone in the use of unmanned technology in US airspace.

The contract comprises aerial mapping and geographic information systems (GIS) work over BP Exploration's Prudhoe Bay oilfield and marks the first time that UAVs will be performing routine commercial services over land in compliance with FAA regulations.

Work began on 8 June, with AeroVironment deploying a Puma AE aircraft equipped with either a custom integrated LiDAR (light detection and ranging) sensor or its standard EO/IR payload.

The sensor payloads produce imagery and data for processing into 3D computerised models of roads, pads and pipelines, along with other actionable information, including precision volumetric measurement and topographic analysis of gravel pits at the North Slope field.

AeroVironment is now performing photogrammetry and LiDAR analysis to survey Prudhoe Bay's infrastructure including gravel roads, pipelines and a gravel pit. The Puma AE is understood to be flying at altitudes of between 200 and 400ft at less than 40kts to provide data.

Tim Conver, chairman and CEO of AeroVironment, said: 'Thanks to the FAA's rigorous, safety-focused certification process for UAS, BP and AeroVironment have launched a safer, better and more cost-effective solution for managing critical infrastructure and resources.

By Claire Apthorp, London

ROV sea change required, warns Saab

While militaries continue to garner benefits from increased synergy with commercial industry, they still require a change in mindset regarding the use of ROVs, industry experts have warned.

'We develop our systems closely in cooperation with our customers, however it is sometimes really frustrating to work with defence as they do not tell us what they need,' said Chris Lade, Saab Seaeye's defence sales manager, at the Undersea Defence Technology (UDT) event in Liverpool on 10 June.

Commercial business has overtaken the military in the development of underwater vehicles, with civil users also boasting more operational hours and experience than their military counterparts.

Lade stated that navies need to change their mindset about the use of ROVs, as well as their specifications for use in the MCM role.

'We always thought of specific roles for specific vehicles, such as in MCM, but we can think about ROVs to be used for a variety of tasks,' he said. 'Sometimes we over-spec, which drives the price up. Signature, for example, is of major importance in MCM, but how far do you want to go? You are measuring against the worst case.'

Conversely, military buyers think that industry is not always sufficiently clear on the real performance of its products, an issue that can only be solved by enhanced discussion and cooperation.

'I do, however, view our collaboration with the US Navy as successful. Other countries are indecisive when it comes to the future of autonomy in MCM,' Lade said.

'In the [UK] Royal Navy, we haven't moved on as we should have done in the unmanned world,' he added.

Part of the problem is also the failure of the commercial sector to invest in defence-related R&D, and a reluctance by companies to share their innovations with other businesses, which Lade called a flawed strategy.

By Joyce de Thouars, Liverpool

On the web

Integrator completes 24hr flight with increased payload
23 July 2014

Simlat develops Maveric S&T solution
21 July 2014

P.1HH HammerHead UAV flight modes validated
18 July 2014

Maiden 'unmanned' flight scheduled for SW-4
18 July 2014

Selex ES UAVs ready for Italian Army deliveries
17 July 2014

Rotron to supply engines to CybAero
17 July 2014

Thales launches Free-Fall LMM
14 July 2014

Australian Heron detachment extended to end of 2014
10 July 2014

Global Hawk flies in NATO Joint ISR exercise
9 July 2014

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27 June 2014

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UK CAA laments lack of UAV integration

Photo: USAF

Recent flights of a USAF Global Hawk in UK airspace have highlighted a lack of progress in integrating large UAVs into the national air traffic control network, a Civil Aviation Authority (CAA) representative has observed.

In May, the HALE UAV flew three sorties – mainly over the sea – in the UK as part of NATO's *Unified Vision 2014* exercise, marking the first flight of this kind in the country.

Although the British Army's new WK450 Watchkeeper was granted its interim release to service in March this year – which allows it to be flown by army personnel in segregated airspace – on the civil side progress remains slow for this size of platform, Mark Swan, director of the Safety and Airspace Regulation Group (SARG) at the CAA, told a Royal Aeronautical Society conference on 10 June.

'There is no civil system of this shape and size flying in the UK,' he noted. 'According to the forecast made in 2011, I expected something big and beautiful to be flying now.'

Swan noted that there is airspace in West Wales available for the integration of this class of aircraft, although only military systems have been flown there to date, including Watchkeeper.

'On the larger side, it's been very disappointing,' he added. The Department for Transport partly funds the SARG's efforts, and Swan pointed out that funding is available to support UAS integration efforts.

An updated CAA strategy for UAS is expected to be released in October, which Swan said he is pushing to be made publicly available as a source of information. A small UAS safety case template is also expected to be released.

Currently, small UAS of 20kg or less can be granted permission upon request to fly in UK airspace, with Swan noting that 217 such permissions had been granted in 2014 up to 1 June, while 318 were issued in 2013 and 133 in 2012.

BREAKING THE LAW

'So long as you ask for the permission, it will be granted,' Swan continued. 'Although there have been a few prosecutions in this country, it was only because they didn't ask for permission.'

Swan was referring to Robert Knowles, who reportedly flew a remote-controlled aircraft over a BAE Systems plant at Barrow-in-Furness, and on 1 April was subsequently found guilty and fined £800 for breaching the UK's Air Navigation Order.

Lawrence Clift, a photographer, has also been cautioned for using a quadcopter aircraft 'for commercial gain without permission', after he sold footage of a school fire taken by the UAV without receiving authority from the CAA to fly it commercially.

'We will not be blockers to innovation and change… but there will be speed bumps,' Swan continued. 'From the national perspective… we as a regulator cannot beat the commercial market.'

He said regulators 'have to be much smarter' about how to do business in this area, and he looked ahead to a time when UAVs will be 'something like a flying mobile phone', whereby everybody has one.

'We want to see – and I'm mad keen on this – UAS as being just part of the aviation landscape, no ifs, no buts,' he concluded.

By Beth Stevenson, London

Boeing's X-Plane set to spawn

Boeing's Phantom Works has claimed its offering for DARPA's Vertical Takeoff and Landing Experimental Plane (VTOL X-Plane) programme has the potential to spawn an entirely new family of systems in the future.

Released in 2013, the VTOL X-Plane effort is aimed at shortening mission times and increasing 'the potential for successful operations', according to the agency.

'When successful, we will see a whole family of systems coming out of this,' business development executives at Phantom Works claimed, describing how such systems could be manned, unmanned or optionally piloted.

Requirements for VTOL X-Plane include: flight speeds up to 400kt; improving hover efficiency from 60 to 75%; a lift-to-drag ratio greater than ten (up from five to six); and capability to carry payloads of over 40% of its 4,500-5,400kg gross vehicle weight.

According to Boeing, its 'Phantom Swift' prototype will considerably extend the flight envelope of existing aircraft, including the company's V-22 tiltrotor platform.

The Phantom Swift offering features two open-body and two tilt-wing fans designed to increase controllability, and is the result of a rapid prototyping initiative. The aircraft measures 13m from nose to tail with a 15m wingspan. Competing designs are being developed by Sikorsky, Aurora Flight Sciences and Frontier.

The $130 million programme will run through to February 2018.

By Andrew White, St Louis

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Anti-poaching groups in Africa continue to fall short in apprehending the perpetrators, although UAS technology could be the much-needed solution. **Andrew White** talks to those active in turning this concept into reality.

Hunting the

As the proliferation of unmanned technology continues to spread across an ever-expanding inventory of applications, it will be comforting for many to witness the genesis of its utility in wildlife conservation and, more specifically, anti-poaching.

According to the Save the Rhino organisation, the number of rhinoceros poached for their horns in South Africa had risen from 13 in 2007 to 668 in 2013. As *Unmanned Vehicles* went to press, over 500 had so far been killed this year.

Meanwhile, the poaching of elephants, according to Monitoring the Illegal Killing of Elephants, presents even more worrying statistics, with a total of 22,000 killed across 27 African countries in 2012 (although this figure represents a reduction from 25,000 in the same area of operations during 2011).

Add to this an unconfirmed number of rhinos sedated by tranquiliser darts before having their horns removed while unconscious, and one gets a brief outline of the challenge facing anti-poaching organisations. Unofficial sources confirmed to *UV* that just 3% of poachers were normally caught by authorities.

UNMANNED APPLICATIONS

There are multiple efforts ongoing across Africa and elsewhere, including Southeast Asia, aimed at combating poachers, with the majority utilising UAVs as a part of the wider tool kit of tactics, techniques and procedures (TTPs).

Founded by former Australian special forces operator Damien Mander, the International Anti-Poaching Foundation (IAPF) is one such organisation trail-blazing the utility of UAS in this area.

Its website reads: 'In the same way that Damien has brought military skills and discipline to the training of anti-poaching rangers, the IAPF now intends to use military-derived drone technology to support those rangers in their work.

'Because we are committed to providing a very capable and effective solution, it will be expensive, far more so than the small hobby-style vehicles we see turning up in Africa almost every week now and which many hope will be a viable anti-poaching tool.'

The IAPF describes itself as a 'scaled-down version' of a comprehensive military capability, and is attempting to steer away from 'very low-cost, electric-powered miniature drones – essentially radio-control models fitted with a camera and [hand-launched]'.

The website continues: 'While valuable for daylight survey of small areas, the short endurance and limited payload ability of these vehicles makes them unsuitable for many conservation activities, in particular anti-poaching support in large areas of Africa and other parts of the world.'

STRATEGY MAKERS

Spearheading the IAPF strategy is Ian Mackenzie-Ross, UAV programme director, and Simon Beart, UAV technical development manager, who began initial efforts to deliver a UAV capability to the organisation in 2012.

To date, they have operated multiple airframes in Australia as part of an ongoing test schedule, following earlier proof of concept trials in Mozambique. Having evaluated what they dubbed 'entry-level stepping-stone' electric motor UAVs, such as the X8 Skywalker and other 'foam-winged' platforms, it became apparent that such systems lacked the payload capacity and endurance required for anti-poaching operations, although they concede that such air vehicles would have some utility.

Currently, the pair have procured multiple Mugin fixed-wing platforms from China and modified the underbelly and engine, allowing a payload of up to 6kg to be carried at an endurance between three and four hours.

'This is the sweet spot for what we're trying to achieve,' Mackenzie-Ross explained to *UV*. 'We trialled foam-wings with 30-40 minutes endurance and a GoPro [camera] strapped underneath, but this did not fit our requirements.'

He added that trials mounting a fixed FLIR camera on board the Skywalker had resulted in a stable platform, although payload capacity remained too small.

The Mugin has a 3m wingspan and a maximum take-off weight of 25kg. It requires a runway to take off and land, although the IAPF team is considering a number of recovery options, including stalling of the air vehicle into a capture net.

'We're looking to try these things in a controlled environment in Australia before we

UAVs operating in the African bush are facing a series of significant challenges as they attempt to counter the poaching threat.

hunters

deploy into the African bush, where we could be hundreds of kilometres from a decent landing strip,' continued Mackenzie-Ross.

COST CONCERNS

However, funding remains a critical issue, especially for charities looking to enter the unmanned domain. According to Mackenzie-Ross, the IAPF's ideal UAV solution lies between two and three orders of magnitude out of its existing price range.

'With the acquisition of a payload worth between $50,000 and $60,000, you're not far short of $100,000 to get a fully equipped vehicle into the field,' he explained. 'But we need more than one airframe if we are going to deploy into Africa. Ideally, three or four, with at least one fully equipped with autopilot management system, gimbal and ground support. That's the bare minimum.'

Another major effort in the anti-poaching domain is being undertaken by Kashmir Robotics and the South African Reserve Protection Agency's (RPA's) International Wildlife Conservation UAV Challenge (wcUAVc), which aims to 'foster innovation and invention in the design, fabrication and utilisation of unmanned aircraft to assist with counter-poaching and illicit wildlife trafficking'.

According to the RPA, the finals for the competition will take place in November at the organisation's HQ on the Amakhala Game Reserve. Indeed, an agency spokesperson told *UV*: 'On a recent fact-finding mission for the wcUAVc, the Aurora Skate UAV was deployed in Kruger Park and Amakhala Game Reserve. The results were positive, giving the wcUAVc the confidence to continue its quest in utilising UAVs in the conservation/anti-poaching world.' The competition involves 140 teams from the international community.

One such participant is Ryan Driesel, flight test director at Team Oxpecker (a group of enthusiasts from Portland, Oregon), who sees a hand-launched system as a good way to approach anti-poaching. 'You don't need a runway and it can be operated at very low cost,' he explained to *UV*. 'This seems to be the main driving factor for these types of operations.

'We would launch, fly the mission and recover the aircraft under full autopilot control, in which we would have real-time re-tasking if the sensors picked up something interesting. For the contest, we expect to run a mock patrol scenario while performing some re-tasking requests in real time.

'Endurance is a marginal concern due to the weight versus structure strength, since we have to carry so much in battery power,' he continued.

As far as take-off and recovery is concerned, Driesel outlined up to several options, including: hand-launched (with belly landing on semi-smooth terrain) and VTOL platforms; traditional runway vehicles; and runway-independent systems that require a launcher and recovery system.

ON THE UP

Additionally, it appears the concept of operations regarding anti-poaching action continues to evolve. The IAPF has initially opted for a conventional take-off and landing UAV, but the use of a small, 'over-the-hill' reconnaissance airframe (normally hand-launched) will present further opportunities to rangers deploying on the ground.

According to Mackenzie-Ross, the ability to respond to intelligence, position, launch and ➤

The Chinese Mugin UAV, as acquired and modified by the IAPF, allows for up to four hours endurance. *(All photos: IAPF)* get to a designated area of operation within an hour is critical to an anti-poaching patrol. Furthermore, he admitted that flying semi-regular patrols could act as a deterrent, providing a psychological impact on poachers who have crossed into a game reserve.

'The bad guys don't know what our capabilities are, but we need to fly covert and semi-covert surveillance flights at night as well, especially during high-risk times when the moon is at its fullest.'

AIRCRAFT ACQUISITIONS

The IAPF is looking to use the Mugin to survey 20km^2 blocks of reserve in a three-to-four-hour mission window for 'perimeter or hotspot' searches. Beart explained that this would cover general patrolling duties as well as reaction capability to specific intelligence-led threats. The airframe is currently carrying a 700g ITAR-free payload comprising a FLIR and colour camera, although he admitted that the IAPF was considering sensor options such as fusion optics, which blend thermal imaging and image intensification.

Poaching teams, normally subsidised by syndicates worldwide, are generally considered to operate in teams of between two and four, including a rifleman, tracker, local fixer and getaway driver.

'They will hack off horns and tusks and rendezvous at the fence line with a guy who will take the merchandise and move it to a port in that area where it will be sold on,' Mackenzie-Ross said.

However, he described how TTPs of poachers varied across the continent, especially in Kenya and South Africa. 'Some [poachers] are ex-military and very "bush-savvy",' he continued. 'They know exactly how to evade capture and avoid detection using low-lying areas, cover their tracks and are aware that dogs are an active anti-poaching asset. Poachers in some areas even use dogs themselves to aid in tracking wildlife. They are also equipped with low-end night vision supplied by the syndicates. There are also cases where helicopters have been used to snipe at the animals before ground teams finish off the job.'

IAPF founder Damien Mander (right) inspects an elephant carcass following a strike by poachers in South Africa.

One anti-poaching source told *UV*: 'In Kruger National Park, most of the poachers walk in on foot from other countries and walk out when done, camping along the way.'

However, the IAPF appreciates that a UAV is not a solution, but just one tool in the box: 'It has opened up a lot of opportunity to assist in this fight, and when an anti-poaching team is on the ground and they know a UAV is overhead supporting them, their morale is boosted by 200%.'

At present, operating altitudes vary depending upon the types of camera and lenses used, but Beart admitted that a typical flight would see Mugin cruising at between 1,000 and 2,000ft AGL. 'There will be times when we will be lower and higher, but we will remain below 5,000ft at all times,' he added. 'This helps in the regulatory framework as well.'

CAN OF WORMS

Indeed, Mackenzie-Ross describes the regulatory landscape as a 'big can of worms', telling *UV*: 'The South African Civil Aviation Authority [CAA] is in a state of flux at the moment [as regards] UAVs and regulation. There are no regulations and they have taken the approach that nothing flies until regulations are in place. But there are case-by-case approvals.

'We have put forward a very professional safety case and risk assessment and dispensation in the national parks does exist,' he continued, describing how some regions had been declared 'restricted military areas'.

As it stands, the IAPF admitted to *UV* that it would not be able to currently deploy its Mugin solution in Africa, with Mackenzie-Ross conceding: 'We could make the case to the CAA, but these things can sometimes disappear into regulatory limbo. There is a reluctance to take risk here, but they would be taking a much lesser risk talking to us than a lot of the "cowboys" in the game at the moment or from hobbyist/conservation folks who think it's their god-given right to fly [a UAV] any time and anywhere they want.'

Ideally, the IAPF would welcome a multi-tier approach from unmanned technology in anti-poaching TTPs, with the addition of smaller 'over-the-hill' reconnaissance platforms, unattended ground sensors and potentially UGVs. 'An over-the-hill asset by itself has little value, but in a multi-tier approach, it can help area search capabilities – even the quadcopter has its place,' Beart observed.

'If it works, it has a place and the next step is linking into the bigger picture using sensor fusion, if you will. There is a lot of intelligence-driven stuff out there, and opportunities to mimic what happens in a military context.'

Referring to the holistic approach to unmanned systems, however, Driesel is realistic about the restrictions a UGV would encounter in the bush environment. 'One thing that might work to aid in this is a technology that Chicago, [Illinois], is testing for crime,' he said. 'It has sensors around the city that detect gunshots and triangulate them before dispatching police. However, it would have to be able to detect over the noise of the spinning propeller, and unfortunately if a gun has gone off, it is probably too late for the animal. But it could prove very useful for apprehending poachers.'

It is clear that UAV applications in the anti-poaching domain appear immature at present. However, according to Mackenzie-Ross, with enough time and funds, many organisations will be able to reduce rhino and elephant poaching, among others, not only in Africa, but on the Asian continent.

'The sky is the limit with this semi-persistent, affordable surveillance asset. We have had requests from Nepal and India, and quite a few organisations are discovering the limitations of over-the-hill assets. So we have got some exposure and got some interest,' he concluded. uv

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As AUVs take their turn in the media limelight, **Ashley Roque** canvasses developers about their future capabilities, data transmission challenges and the prospect of full autonomy.

Operators move the USN's Bluefin-21 AUV into position for deployment during the search for Malaysia Airlines flight 370. *(Photo: USN)*

Drone. The simple word sparks an array of reactions across the globe, from fear of unwanted surveillance to a novelty item recording a wedding. While much attention has been placed on UAVs such as the US military's MQ-1 Predator, high-profile operations such as the underwater search for Malaysia Airlines flight MH370 have thrust the proliferation of AUVs into the public spotlight.

Due to the underwater environment, AUVs searching for mines and surveying pipelines operate more autonomously than their surface counterparts. While autonomy does not equate to artificial intelligence, industry insiders expect that as AUV customers become more comfortable with the technology over the coming decade, platforms will be entrusted with increased decision-making powers.

DEEP BLUE

Navigation and data collection in austere ocean and freshwater conditions are not easy.

'No GPS, no real-time, wideband, over-the-horizon RF link, no hands-on operator,' Per Espen Hagen, system architect and senior principal engineer in Kongsberg Maritime's AUV R&D department, explained to *Unmanned Vehicles*. 'Yes, you can have acoustic communications, but only when there's a surface ship or other infrastructure relatively close to the AUV.'

Despite the autonomous nature of the AUV, militaries today rely on data provided by sonar and other sensors to make operational decisions while mine-hunting or carrying out an environmental assessment.

In a written statement to *UV*, the UK MoD said that its AUV missions are always operated by a trained member of the armed forces.

'These vehicles provide environmental data and intelligence, some using high-resolution sonar systems, to give our people a full picture of the environment in which they are operating and support decision-making ahead of operations,' the spokesperson said.

But striking a balance between autonomy, collecting real-time data and handing over decision-making capabilities is expected to be a delicate task, as operators learn to trust the technology more.

MISSING FLIGHT

Nearly five weeks after flight MH370 disappeared, the Australian government deployed a Bluefin-21 AUV – equipped with a sidescan sonar – to search 860km^2 of the Indian Ocean. Over several weeks, 30 missions to depths between 3,800 and 5,000m were completed, according to the Australian Transport Safety Bureau's 'MH370 – Definition of Underwater Search Areas' report.

Each mission lasted nearly 20 hours – two hours for the AUV to descend, 16 hours of data collection and another two hours to reach the surface, Bluefin CEO David Kelly told *UV*.

One of the key lessons learned from the search revolved around how the team wanted to operate the vehicle. 'They [wanted] us to do initial data processing before they started the next mission,' Kelly explained. 'In other applications, the data would be offloaded and the vehicle would immediately start on another mission. But here, given what they were doing, they did want to take a look at the data that had been collected.'

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Since the initial deepwater search for the missing jet concluded in late May, the Australian government is stepping up plans for a larger search to cover 60,000km^2 of water.

Kelly said there are logistical challenges associated with a wider search area. For the initial search, he explained there was one stretch where the single Bluefin-21 was used on 19 consecutive days. He added that key to keeping the AUV running were 'preventative maintenance actions', additional support availability on-boat and a 'reasonable' spare-parts kit. If the AUV could not be fixed on the boat, the team would lose several days by returning to port.

'So, you are looking for technology that you can mobilise on a ship with the requisite support and spare parts to enable you to run for the types of survey durations you want, without having something you don't have the spare part for, Kelly explained. 'That's the challenge, to get an efficient, cost-effective search done.'

While Bluefin Robotics is not submitting a bid for the new search, it is providing others with information to use in the bidding process. The USN supplied the Bluefin-21 for the previous search.

In the 2010 search for Air France Flight 447, the Woods Hole Oceanographic Institution used a Kongsberg Remus 6000 to find the aircraft in the Atlantic Ocean.

Hagen said Kongsberg is 'developing' a Hugin-class AUV that could reach 6,000m. However, he declined to say when it would be operational and if it would be used in a bid for the extended search for the Malaysian flight.

DATA OR AUTONOMY?

The Bluefin-21 operators searching for MH370 were eager to review data before relaunching the AUV. But for missions at lesser depths, options can be made available for customers looking for quicker avenues to analyse data, according to Sonardyne business manager for maritime security, Nick Swift.

For example, a fibre-optic cable attached to the AUV can reach back to the surface vessel to send imagery in near-real time. 'But you've got the disadvantage that you've got it tethered,' he explained.

A second option is using optical communications to relay data. Under this method, a 'dunker' attached to the surface vessel is lowered into the water. Once it is within 100m of the AUV, it can access

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A Bluefin-12 enters the water to perform a short mission along a 500m runline at a depth of around 15m. *(Photo: Bluefin Robotics)*

sensor data, Swift added. Yet another option, according to Hagen, is for the AUV to surface to transmit data via satellite.

Although these methods provide the operator with data more rapidly, they all alter the way the platform is utilised.

While the mission decides how quickly sonar data is needed, Hagen explained that Kongsberg's AUVs – equipped with two-way acoustic links – allow controllers to configure the sensors during a mission, receive error messages and transmit small packages of compressed sonar data to the operator.

'In 1997, when we surveyed a pipeline route in the Norwegian Sea for the oil company Statoil, there were two alternate corridors,' Hagen explained. 'Just a few hours into the AUV survey of the first route, the onboard representative from the oil company decided from the acoustically transmitted sonar data that the area was too rough, and told us to move to the alternate route.'

Although the technology can be helpful in some situations, he noted that when military AUV users operate in shallow water at a stand-off distance to the surface vessel, bandwidth for acoustic communications is very limited. To meet this challenge, Kongsberg is in the process of transitioning to a new acoustic link technology, which allows for higher data rates in horizontal geometries.

Hagen stressed, however, that near-real-time data may not always be an advantage: 'There is no single answer to what is the right solution. It actually very much depends on the application. I think there is a traditional view that you have to get the data as fast as possible, but when you start developing concepts of operations, specifically, in many cases, it's not really a problem if you get the data after say, 12 hours or six hours… it really depends on the application.'

For example, if an AUV is searching for mines and has collected enough data, is it critical

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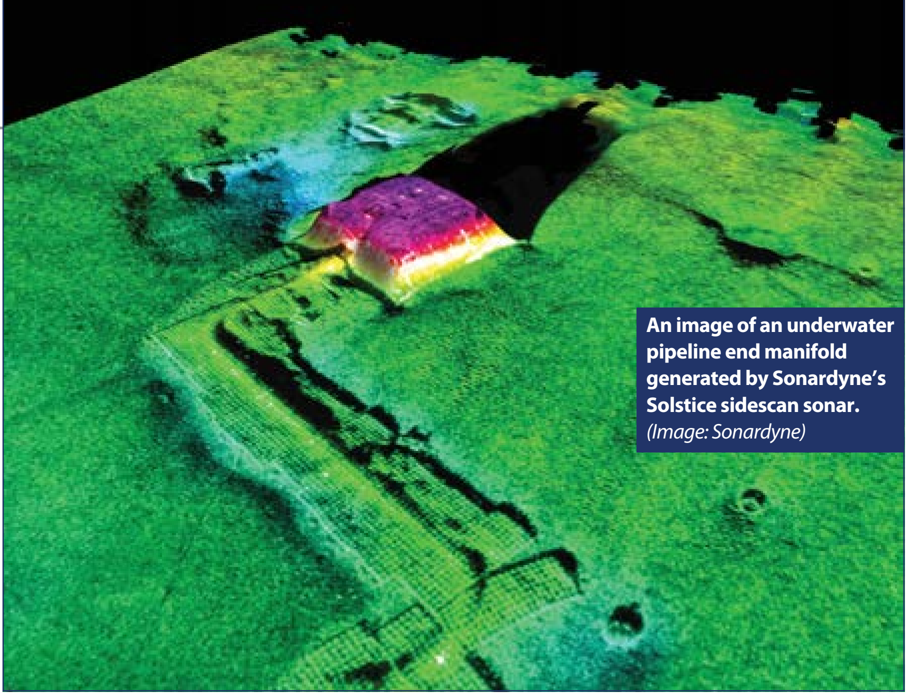

An image of an underwater pipeline end manifold generated by Sonardyne's Solstice sidescan sonar. *(Image: Sonardyne)*

for the operator to have that data as quickly as possible or for the AUV to be programmed to make a decision?

'We're really not talking about days or weeks here,' Hagen added. 'We're talking about hours and a mine countermeasure [task] is inherently an operation that takes time. You don't want to start shooting up mines while the [AUV] is surveying right next to them.'

But how much decision-making power should the AUV have?

MAN OR MACHINE?

While industry is providing operators with options to monitor near-real-time data, developers reiterate that AUVs will likely become more autonomous and tasked with more decision-making.

'We will see more of AUVs aggregating knowledge, to the point where the information they need to transmit back to an operator is very small,' Hagen said. 'A lot of the technology is there, but it takes time to build trust with the operators and change the concept of operations. Questions may then shift to "should I trust my AUV when it says it has automatically found all the mines in the area, and send the convoy through?"'

While industry is testing technologies that would increase autonomy, this is still 'just scratching the surface' and there will be 'a lot of changes' in the coming decade, Hagen opined.

One key element in pushing the technology forward will be naval operators who have only just begun utilising AUVs.

'You really have to use autonomous technology in parallel with having operators manually assess the data,' Hagen said. 'I think once you see that the AUV agrees with you, and maybe even finds things that the operators don't because of fatigue and so on… I think it will happen. It's not something you can force really onto customers.'

BALANCING ACT

While progress on autonomy continues, optimising an AUV sonar's weight, volume, cost and power consumption remains an ongoing problem.

One of the challenges is striking a balance between high-quality imagery with a good coverage rate, and low power consumption. 'Sometimes it is like looking through rain. Sometimes it is like looking through bright sunlight,' Swift explained. 'It's actually designing the system that can perform in those difficult environmental conditions, with low power… and still give you good imagery.'

At the same time, everything has a cost. If the customer wants extreme performance in too many areas, Hagen warned that they will end up with a very large AUV – perhaps too large.

In addition to balancing these factors during the design process, issues can also become apparent once the sonar is integrated onto the vehicle. While Kongsberg is developing AUVs alongside bespoke sonars, other companies are teaming up at the development stage or further on in the cycle.

Sonardyne, for example, has spent nearly four years developing its new Solstice sidescan sonar which it describes as a 'step change'.

'A conventional sidescan is the way to go because it has specific characteristics – they can operate in quite difficult environments, they can be low power,' Swift said. 'But to get the resolution and coverage, we really kind of almost started from a clean sheet of paper.'

Although they are not exclusively working together, Sonardyne and Bluefin teamed up earlier this year to integrate Solstice on the Bluefin-12 AUV before holding two demonstrations – one off the coast of Alaska and the other off Boston, Massachusetts.

As militaries become more accustomed to operating AUVs, industry officials say they believe the market will rapidly grow.

'In terms of the AUV right now… it's a relatively new technology, so we see them being kind of adopted and really growing into the roles they are designed for,' Swift said. On the mine countermeasures front, for example, he added that there has been a lot of work assessing how AUVs can be used for this mission in the future.

MARKET SHARE

'I think over the next couple of years, particularly in the military, you are going to see them being used a lot more,' Swift observed. 'So we do think the market is going to take off.'

Bluefin is also banking on an expanding market. Kelly explained that there are 'a lot more capabilities to do a lot more processing of sonar data', both on the pipeline surveying front, and for automatic target recognition, which means the capability will become more mainstream in future.

'We have the capability to send up, acoustically, snapshots of the sonar data to support data quality and other verification activities,' Kelly added. 'So in the future, we see the ability to process the sonar onboard, and if an object of interest comes up, be able to identify it and send an image of it to an operator on the surface or at a shore station, to review it.'

Industry leaders are also poised for AUVs to take more and more of the reins on the decision-making front as military officials become more comfortable with the technology and capabilities.

'They need to sort of get used to the idea of having these autonomous robots out there before they are ready to take that next step,' Hagen concluded. UV

The enhancement of EO/IR payloads has been a key element in the proliferation of UAS over the past decade. **Scott R Gourley** examines the sensors that have been central to this growth and those pushing the boundaries further.

An eye for detail

A US Army Gray Eagle equipped with the Common Sensor Payload at Dugway Proving Ground during the *MUSIC* exercise in 2012. *(Photo: author)*

When asked to characterise the broad evolution of UAS sensor applications over the past decade, Lars Ericsson, chief of the technical management division within the US Army's Unmanned Aircraft Systems Project Office, is quick to describe it as 'progressive' in nature.

'To contrast then and now, the changes in the middle-sized payloads in the 30-50lb [14-23kg] range and the large, for us, 150lb class, have not been radical,' he said, noting that the progression path has included 'bringing the laser designators down to that mid-sized category, as well as the migration of HD for both EO and IR'.

SMALLER SCALE

Shifting his perspective towards small UAS, which for the US Army are generally considered to be 20lb and smaller, Ericsson outlined current solutions in the Raven and Puma AE platforms.

'The big change in small UAS over the [past] ten years is the combined EO/IR payloads,' he said. 'The EO side of that became HD-sized focal planes, but we usually put standard-definition [SD] images and frequently use the extra pixels for electronic image stabilisation – although we can also do higher resolution EO images. The big change was bringing those together and then gimballing them to get better net sensing performance in the small UAS.

'If you go back ten years, we had separate "noses", if you will, for the Raven class [UAS], and they were hard-mounted to the airframe. So every time we hit a bit of turbulence the image would slew around. But now we're procuring gimballed, combined EO/IR.'

He continued: 'Laser pointers also came into that [small UAS] category as an adjunct. We don't, at this point, have solutions for designators. The closest we got was the [Future Combat Systems (FCS)] "Class I" Mission Equipment Package payload, which was about a 7lb payload back in the FCS programme. It ended up not having an acquisition tail, but it's an available technology in that size range. We don't currently procure it, but it is there in the marketplace.'

Ericsson explained that 'the other side' of the technology developments noted involved parallel advances in the processing, exploitation and dissemination (PED) architecture.

'We have the technical ability to do that all the way down to the small UAS,' he said. 'But it is more typical from the mid-size, like Shadow, and up, where those are disseminated across an entire theatre.'

SCREENING PROCESS

One area of PED advancement noted by Ericsson involved the ability to share and exchange full-motion video (FMV) across coalition forces by using standards like NATO STANAG 4559. He credited the entire community with doing 'a very good job of moving to standards-based interoperability and also developing in *OEF* [Operation *Enduring Freedom*], fielding and utilising appropriate cross-domain solutions that handle different classification levels for moving video between different parts of the US force and then also particularly for the coalition'.

'So we're marking the video at creation, with its metadata about its classification and ability to share,' he continued. 'And then we're

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> *'There's been a real sea-change of it becoming much more the norm that metadata is attached to the FMV.'*

using things like 4559 and other tools in the digital video end of the world to disseminate it.'

He added that a key enabler of the dissemination process has been the preponderance of digital video throughout the system.

'Ten years ago, there was almost invariably a point at which the data was analogue, with disconnected or non-present metadata,' he said. 'In this case, it was the rest of the data that supported the FMV by providing the aircraft location, the sensor and aircraft orientation, the fields of view, perhaps even the calibration data for the optics, etc. And that's been a real sea-change of it becoming much more the norm that metadata is attached to the FMV, and frequently all the way from creation. So that's a huge improvement in the usable quality of the video.'

Many of the developments noted by Ericsson were subsequently highlighted by a sampling of industry representatives.

Paul Jennison, VP of government sales and business development at L-3 Wescam, noted the expansion and refinement of the company's MX range that currently spans products from 10-25in (25-64cm) in diameter.

'Basically they're all multi-sensor systems that have at their heart a thermal imager, with multiple televisions and lasers packed in them,' he said. 'They're sort of plug and play, depending on what customers want to do on a mission.'

UNMANNED EXPOSURE

Although the company's mainstream business on the 'air side' has been focused on fixed- and rotary-wing manned platforms, Jennison noted MX exposure in the UAS market, pointing to the Falco UAV from Selex ES, which can take either an MX-10 or MX-15 sensor.

'We've been on other UAVs, like Frontier Systems' Hummingbird and the BAE Systems Mantis, but those really didn't go into rate production,' he added.

The company's most recent UAS milestone was its selection as the second source supplier for the Shadow's sensor, which Jennison said would likely translate to 'a combination of MX-10s and MX-10Ds'.

'What has changed in our product line since 1997 was about five or six years ago we went from analogue to digital systems,' he said. 'Since then, we've added more sensors into the mix. Shortwave IR has come in vogue, so we offer that in all our capabilities.'

A demo at SOFIC 2014 in Tampa, viewed through an MX-10 sensor payload. *(Photo: L-3 Wescam)*

Jennison said that near-term efforts will also include the company's introduction of a new 7in-diameter turret at the small end of its MX line. This turret has four payloads: IR; FMV; laser rangefinder; and laser pointer.

'The 7in turret has been through flight trials and we got good results,' he said. 'It would fit something like an Insitu UAS [the company is also developing a larger 165lb air vehicle] or maybe an Aerosonde-type UAS. It's really like a 10lb sensor versus our MX-10, which is like a 35lb sensor.'

SAME ARCHITECTURE

Asked about technologies that paved the way for the pending introduction of the 7in turret, Jennison explained that all of the MX systems have the same basic architecture: four-axis systems; stabilised; and isolated.

'Basically, the miniaturisation of some of the technologies allowed us to scale that down to the 7in class,' he said. 'There are inertial measurement units available now allowing us to get a good location capability out of it and gyros that are small enough to use on stabilisation. And there is always somebody who wants at least one attribute out of the sensor – either really great imagery or really good target location accuracy. This has scalable imagery that people would expect from Wescam, but also target location accuracy. In the UAV environment, that's kind of a key discriminator, so we've got very good target location accuracy out of it.'

Another industry example that is reflective of Ericsson's comments regarding the introduction of HD capabilities into EO/IR sensors was Raytheon's development and initial demonstration in late 2012 of a new Common Sensor Payload (CSP) HD turret, an HD EO/IR version of the company's CSP on the US Army Gray Eagle UAS.

Built upon the existing CSP system, CSP HD – which is available for new production or retrofit to existing CSP SD units – provides significantly improved image quality and resolution compared to legacy systems.

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INDIVIDUAL DIFFERENCES

Accompanying the improvements in sensor packages have been upgrades in individual camera and sensor components. Examples can be found in a number of different cameras options from FLIR Systems.

According to Jay James, VP of global OEM business development, the company currently has three camera modules/sensors for UAS applications – Tau, Quark and Lepton.

'They vary in size, weight and power, depending on the UAS needs,' he explained. 'Tau, which weighs about 75g and uses 1W of power, is the largest and most widely fielded through multiple OEMs who integrate the cameras into their systems. At this point in time, I think we have something on the order of 10,000 Tau-based cameras integrated in UAS around the world.'

The company recently released Tau 2.7, which includes sensors up to 640x480 resolution, longwave capability , uncooled devices and image enhancement for better picture quality in different scene conditions.

FLIR has fielded a smaller number of Quark sensors, which use the same amount of power as Tau, but are a little less than quarter of the volume and approximately a quarter of the weight at 20g.

'We have one particular customer we're selling a good number of these to, and they are integrating them into a couple of different airframes,' he noted. 'If you are size- or weight-constrained – not so much power – Quark is a great option for those customers that have even smaller UAVs or are trying to fit more and more sensors into an existing UAV.'

Lepton is the third camera in the FLIR family. Introduced in January 2014, it has much lower resolution – currently 80x60 pixels – when compared to 640x480 for Tau and Quark. 'But it's much smaller,' James said. 'We've now gone from approximately 20g for the Quark to 0.5g for the Lepton camera. And it also only uses 150mW, so you've cut the power by almost a factor of ten.

> *'G2 have put a lot of effort into studying what they would like to see. And one thing might be a higher resolution, longer range EO/IR turret for Gray Eagle.'*

'Some of these new microdrones weigh less than the Quark camera by themselves. So a couple of those folks are now starting to adopt Lepton cameras for these tiny systems where weight is critical. They're not necessarily flying as high as some of the other UAVs, or they might even be in a room. An 80x60 won't give you great resolution at 1,000ft, but if you're 10-30m away you'll be able to see necessary things with Lepton. In fact, we think this is quite a revolutionary sensor for those systems.'

STAMP ON IT

Few product evolutions show the influence of new technologies better than the Stabilized Miniature UAV Payload (STAMP) from Controp. According to Johnny Carni, VP of marketing and sales, the company began developing payloads for large UAVs in the early 1990s.

'The unique thing about our payloads was high quality and performance compared to weight,' he said, adding that stabilisation was always a problem with smaller and lighter systems. 'And when you fly at 1,000ft, that's the worst possible case with vibrations on any platform you might have.'

Controp's STAMP family emerged from an eight to ten-year development process, with features including a three-gimbal design, an IR continuous zoom lens and the ability to move the auto-tracker from inside the GCS to aboard the UAV.

'We began with a 1kg payload with just a day TV camera,' he related. 'Then we incorporated an IR camera; then we developed a dual day/night camera with both of them having a zoom lens; then we went for a day TV with HD camera inside, which of course requires much higher stabilisation.'

He said that the resulting systems are weighing in at from 800g to 1.2kg, 'depending on configuration with/without laser pointer and things of that kind'.

Although the company once shied away from even smaller payloads, Carni added that

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FLIR Systems' Quark and Tau payloads vary in size, weight and power specifications, allowing for more modular approaches to operation. *(Photo: FLIR Systems)*

customer demand drove development of a 250-300g package. Dubbed Micro-STAMP, he said it is currently in the final development stages.

Another customer requirement to integrate a cooled IR camera with the day camera led to the development of the 3kg T-STAMP. The system, with its 3° narrow FOV, provides UAS platforms in the 20kg class with a sensitive and high-quality IR capability.

FUTURE FOCUS

In his own broader 'fleet vision' of the future, Ericsson pointed to a number of tactical and technical developments and their likely impact on future system developments.

Referring to the recent second source payload for Shadow and the 'well established' CSP on Gray Eagle, he said: 'If you look beyond those in the army, you only see one area of really active acquisition and development, and those are for the two companies of Gray Eagle that belong to the intelligence units – the aerial exploitation battalions.

'G2 [intelligence] in their enterprise and partners have put a lot of effort into studying what they would like to see. And one of them might be a higher resolution, longer range EO/IR turret for those Gray Eagle systems as well as their manned platforms such as ARL [Airborne Reconnaissance Low] and EMARSS [Enhanced Medium Altitude Reconnaissance and Surveillance System].'

He continued: 'Certainly for us, from 'Predator A on up we're on a trajectory to multi-sensor. And you find that having multiple modalities on the platform – SAR and FMV, SIGINT and FMV, SIGINT and SAR – you certainly get a synergistic effect that is much more than a 2x in your capability. In terms of slewing to cue, you can get a cue from SAR or SIGINT, put the FMV on it for confirmatory imaging and get the confidence needed before you generate an engageable target from it.'

Another likely technology direction Ericsson identified was the 'metric sensor'. He explained: 'If you look at the current state of the art, the metadata on an FMV stream frequently is derived from an inertial measurement unit on the gimbal of the turret, particularly on the larger turrets, with a laser rangefinder bore-sighted with the imager. At that point, the metadata has a very good idea of the location of the centre of the image and then the corners are estimated, based on the nature of the optics train.'

Describing a metric sensor as 'one of the holy grails that the National Geospatial Intelligence Agency is driving us towards', he said that it uses a 'wide FOV laser rangefinding capability' that 'basically provides ranging to every pixel location on the ground. Particularly the special operators covet that ability to get a 3D model of the image area and put a fair bit of effort into that kind of image processing.' UV

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Danger zone

One of the drivers of unmanned systems development has been the imperative to keep human beings out of harm's way. **Angus Batey** explores how the technology is being deployed in the high-risk arena of counter-IED and mine clearance work.

It is inherent in the nature of warfare and conflict that lessons learned will often be painful. Certain voices within the British military, for example, have pointed out that gains made in critical injury and trauma care may come to be seen as the defining success story of combat operations in Afghanistan – even though the price paid to hone and acquire those skills and techniques has been terrible indeed.

A similarly uncomfortable sense of achievement and advance can be seen in the area of demining and counter-IED work. The IED threat was all but unknown before the beginning of this century, British experience in Northern Ireland notwithstanding. Eradication of the scourge of land mines had become a widely discussed topic and a focus of public attention for some time before the 9/11 attacks in 2001 launched Western militaries on a prolonged series of combat operations in Southwest Asia.

But the two issues have begun to converge, and technologies to tackle both sets of buried munitions have advanced at a rapid pace over the past decade.

In Afghanistan, the hardware available to militaries such as the UK's builds on what existed before deployment to the region, but adds layers of sophistication and complexity to what were often rather homespun roots. Unmanned systems are, understandably, to the fore in counter-IED roles, as the need to keep personnel a safe distance from the target device is paramount. But, increasingly, such systems are part of suites of capabilities used in concert to detect and neutralise the IED threat.

COMBINED CAPABILITY

The British Army's Talisman offers a good example of how a number of different capabilities can be deployed in a coherent way to carry out a particular task centred around IED or mine clearance. The system was procured under a UOR to provide a means by which routes could be checked and/or cleared before convoys or other traffic had to use them.

The main vehicle used is a modified Mastiff, known as Protected Eyes, which uses ground-penetrating radar (GPR) to scan the road ahead for buried objects. A UAV – the Honeywell Tarantula Hawk or 'T-Hawk' – provides overhead imagery of suspicious areas, and is also sometimes used in a low hover to blow dust away from half-buried objects. Once an IED is detected, the Talon UGV, made by British contractor Qinetiq, is among the capabilities that can be deployed to neutralise the device.

Another piece of equipment currently in use is the Mk 8 Wheelbarrow. This is a development of a capability originally introduced in 1970, when British Army officers modified a hospital wheelchair and fitted it with a light on a boom

The venerable Wheelbarrow Mk 8 remains the British Army's principal counter-IED robot. *(Photo: Crown Copyright)*

Raytheon's unfinished SafeRoute concept marries its new Soteria laser acoustic technology to an autonomous ground vehicle. *(Image: Raytheon)*

The unmanned Micro MineWolf MW50 is claimed to be small enough to be transported on a 4x4 vehicle. *(Photo: MineWolf Systems)*

operated by bicycle chains to investigate improvised bombs in Northern Ireland. The current Mk 8 is manufactured by Northrop Grumman subsidiary Remotec.

'That's the main RCV [remotely controlled vehicle] we use,' Cpl Paul Purkhardt told *Unmanned Vehicles* during the launch of Force Troops Command at Upavon, Salisbury Plain, in March. 'It's an amazing bit of kit – really robust and adaptable. We can strap anything onto the side of it. It's quite old now but it does the job. And as the technology gets better we keep upgrading it, by changing the cameras on it, and the motors and actuators.'

Wheelbarrow also offers its operators the same dust-removal capability as Talisman operators have improvised with the T-Hawk.

'We have our own system to put on the RCV, called Quarrel,' said Purkhardt. 'It's a single-cylinder two-stroke leaf-blower. Once the search has uncovered an edge, we'll drive up, rev that to the max, and it'll blow the sand away. We've found a lot of devices that are very poorly put together, and it'll even render them safe sometimes by blowing the wires out of the device.'

A smaller vehicle, Dragon Runner – another Qinetiq product from the Talon family – was procured under UOR for Afghanistan. It is operated by the Royal Engineers' 29 EOD & Search Group, the RN's Fleet Diving Group, and 5131 (Bomb Disposal) Squadron RAF. A version of Quarrel has also been fitted to this platform. The system is being retained as part of the UK's core equipment programme, so it will remain in the inventory after combat operations end in Afghanistan.

SHIFTING FOCUS

While counter-IED work focuses on precise manipulation of small objects, traditional mine clearance is conducted on a different basis. This results in a different set of technological approaches, and the emphasis on unmanned systems is not always as pronounced as it is in other military requirements.

'In mine clearance you look at a variety of conditions in the field, meaning you have to take different factors into account to effectively deploy any kind of technologies,' said Philipp von Michaelis, CEO of MineWolf Systems, a Swiss company that produces a range of manned, unmanned and optionally manned systems for mine clearance roles.

The company has sold over 100 platforms to more than 30 countries since it was founded in 2004, and its customers include NGOs and charities as well as militaries and governments.

'As an example, if you look at a large minefield, where there's an unknown threat but potentially AT [anti-tank] as well as AP [anti-pesonnel] mines, you want a big machine to have the productivity,' von Michaelis

➤

explained. 'If you can afford to have it operator-controlled, you would most likely have better productivity because the person sitting on the vehicle usually has better control than if you have to do it via video control systems or other sensors.'

He pointed out that the additional cost of a remote-control system may be many times the monthly salary of the operators who would be paid to carry out demining work in parts of the world where minefields are commonplace. As well as cost and speed, there are benefits in the precision of the operation, and in certain climatic or geographic situations the capability available via remote control may not be an effective way of carrying out the task.

'You would choose an unmanned system in situations where the operator might face a certain threat,' von Michaelis continued. 'For certain tasks you need smaller machines and, due to pure physics, at some stage it stops becoming viable to put a cabin on the machine. If you have smaller projects, projects in remote locations, at higher altitude, or in difficult-to-reach areas, you need smaller units that can be deployed via a smaller means of transport. And then usually you just don't have space to put a cabin or an operator on top of it.'

THREAT ASSESSMENT

Combining this background in mine-clearance work with emerging experience from counter-IED missions, MineWolf has adopted a platform-centric concept. The key difference is that IEDs, by their very nature, are a threat that is difficult – if not impossible – to predict. A minefield will likely contain mass-produced weapons with known characteristics, blast radii and kinetic effects, so the relevant level of protection can be fielded and risk can be managed.

As no two IEDs are alike, it is impossible to know in advance what levels of protection will be required. Starting with a baseline product that can then be added to in different threat environments – and that can be optionally manned – means that both productivity and system performance can be optimised.

'We always have the suitable platform for a given threat, and that platform is then extended or complemented by certain attachments,' von Michaelis said. 'That could be a tiller, a flail, a robotic arm or a detector. And then you turn that standard platform into a specific, bespoke solution. It was market- and customer-driven – we had to provide very flexible solutions to respond to a threat that, nowadays, cannot be specified.

'It turns out that certain clients say: "No, I want a guy on that machine, because he knows best what to do." Or other clients say: "No way am I going to put a person onto that machine – I'll do it by remote control." We can advise and recommend certain solutions, but at the end of the day it's the client who demands what he needs.'

Existing capabilities have been widely praised and have undoubtedly saved many lives – not just operators who have been kept out of harm's way but also countless civilians who might otherwise have been killed or injured by the devices. But there is still risk involved in both mine-clearance and counter-IED work, and the task is often as slow as it is painstaking.

The 'holy grail', therefore, of the counter-IED domain has been a system which would quickly scan an area and detect suspect devices – even types or designs never previously seen – at sufficient stand-off range to keep operators out of the blast radius. If it can be kept small and light, and competitively priced, so much the better.

ULTIMATE SENSOR

'The ultimate [counter-] IED sensor would work at about 60 miles per hour [95km/h], have a very, very low false alarm rate, and would be able to almost read the writing on an IED,' said Andy Mitchell, senior counter-IED engineer for Raytheon UK.

But such a device does not exist, or at least 'not yet', according to Mitchell who heads a team of four people who have been working on a new solution to the IED detection problem. The first fruits of their labours were unveiled last summer, when Raytheon launched a new system called Soteria.

Using laser acoustic technology, the system was initially designed to be fixed to the front of military vehicles. It can scan an area of approximately 5x3m and detects buried IEDs

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Procured under a UOR for Afghanistan operations, the Qinetiq Dragon Runner is being retained as part of the UK's core equipment programme. *(Photo: Crown Copyright)*

with a very low false return rate. However, unlike GPR, Soteria cannot be used while the vehicle is moving, and the time taken to scan the grid can be lengthy.

'GPR is continuously moving, but only at about one to two kilometres an hour, which is very slow,' Mitchell said. 'But users cannot do what they term as "confirm and diagnose" the target. You know something's there, but you can't say whether it's an IED or a piece of rubbish. It detects almost everything – so you're having to investigate a huge amount of false alarms. Soteria works on a stop-start basis, which is a downside to the technology. But what it gives you is a very low false alarm rate, because it doesn't detect all the rubbish, and with the imagery that comes back, you can see the size, shape and orientation of every target in the ground, so you can confirm and diagnose the target.'

The big breakthrough for Raytheon came in recent months, with the ability to take the Soteria technology and miniaturise it. The resulting product, GroundEye, has just completed successful tests on a simulated Afghan road at Carver Barracks in Essex. 'That was our "eureka!",' Mitchell said. 'We're still tweaking it and there are improvements to be made. The next iteration of the hardware is due to be delivered by the end of July. But it really does work.'

The potential of a system that offers the benefits of Soteria technology in portable form are obvious. At present Raytheon's tests have used a tripod-mounted configuration, but the company is already in discussion with both manned and unmanned vehicle manufacturers – including MineWolf Systems – about offering it as an option on their platforms.

Direct sales to end-users – be they defence ministries or NGOs involved in mine-clearance work – are also being discussed. The company will be demonstrating a prototype to the UK MoD in August, and is willing to offer the system as a service as well as for purchase. 'We want this to save as many lives as possible, so we're obviously open to different ways of doing business,' Mitchell said.

ROUTE SCANNER

Raytheon has also investigated a concept it calls SafeRoute – an autonomous UGV using Soteria/GroundEye technology, which could be sent out to scan a pre-planned route and would send back geo-tagged imagery of any target objects it detected. This idea remains on the back burner, but could be developed further if a customer were to show interest.

As the drawdown of Western militaries from Afghanistan concludes, it would be easy to assume that the 'golden age' of counter-IED technology development may also be coming to an end. Certainly, the money ploughed in to the sector via UORs and other fast-track procurement mechanisms will no longer be available. But von Michaelis argues that the requirement for mine-clearance and counter-IED technologies is not going to diminish.

'I think what we're going to see is that there will be more thinking done on what is actually required,' he said. 'Forces will look very closely at the lessons learned in recent conflicts, and at what they might encounter in a future conflict. They will need technologies, and those technologies will probably be better designed than we've seen in the past.

'Let's be honest, the IED and EOD threat is only going to become more rather than less – we will see much more of that in the future, unfortunately. Forces need to be prepared, and they will look at enhancing technologies they have used. So, unfortunately one could say, I don't see those markets becoming less attractive.' UV

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Upwardly mobile

As a steadily maturing technology, VTOL UAS are gaining critical mass among users and developers alike, finds **Claire Apthorp**.

When viewed against the speed at which fixed-wing UAVs have progressed and been deployed by military forces worldwide, VTOL systems have had a much slower start.

However, a handful of manufacturers have been steadily improving their VTOL technologies, and with the support of a number of early adopters – namely the US military – this class of UAV is beginning to form an integral part of ISR operations, particularly in the maritime environment to which VTOL's inherent characteristics are well suited.

The MQ-8B Fire Scout has been deployed by the USN since 2009. The system, with the ability to remain on station for more than six hours, carries a payload that includes an EO/IR sensor with laser rangefinder/illuminator and a maritime radar, enabling it to find and identify tactical targets, track and illuminate them, accurately provide targeting data to strike platforms and perform battle damage assessment.

Efforts to refine and enhance the MQ-8B's maritime capabilities have been an ongoing endeavour by the navy and Northrop Grumman. In May, the MQ-8B was flown simultaneously with the MH-60R Seahawk helicopter for the first time from the Littoral Combat Ship (LCS) USS *Freedom* as part of work to demonstrate that a mix of manned/unmanned aircraft can increase a ship commander's intelligence-gathering capabilities.

As Fire Scout can fly for longer than the Seahawk, it complements the latter's surveillance capabilities and effectively extends the ISR reach of the host vessel, maintaining constant surveillance on a target or area of interest.

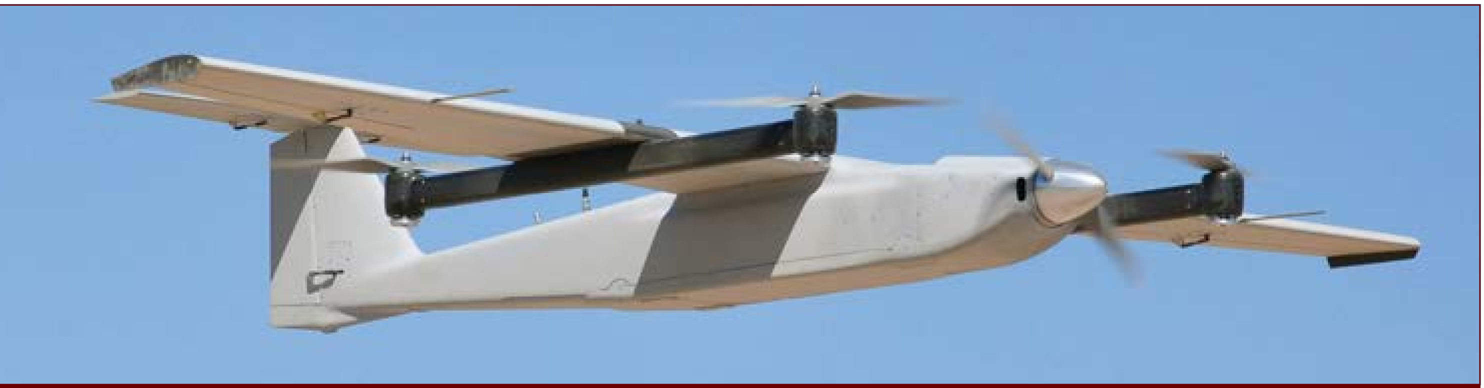
According to RAdm Mat Winter, the USN's Program Executive Officer for Unmanned Aviation and Strike Weapons, 'the aviation detachment assessment marks yet another MQ-8 system success in demonstrating effective unmanned aviation integration at sea. The effective blending of manned and unmanned aviation capabilities on LCS is key to providing our navy the affordable warfighting capabilities they need to be where it matters, when it matters.'

SENSOR SENSATION

In June, the Fire Scout was integrated with a new radar – a modified AN/ZPY-4 multi-mode maritime surveillance unit – to demonstrate the platform's ability to provide wide-area maritime search capability.

Capt Patrick Smith, programme manager at the Multi-Mission Tactical UAS Program ➤

The MQ-8B underwent trials aboard the USS *Freedom* in May to evaluate complementary operation of manned and unmanned embarked rotorcraft. *(Photo: USN)*



The application of JUMP technology to Arcturus UAV systems gives VTOL capabilities to fixed-wing aircraft. *(Photo: Arcturus UAV)*

Office (PMA-266), USN, said that the radar 'is currently being integrated onto the MQ-8B air vehicle and will provide a forward-looking multi-mode maritime surface search radar with spot synthetic aperture radar [SAR], inverse synthetic aperture radar and Automatic Information System [AIS] track processing capabilities.

'Additionally, it will be cueing to the EO/IR sensor from a radar track. This upgrade increases the situational awareness and threat warning in a high-traffic littoral environment. Fire Scout's deployment with the new radar is planned for 2015.'

As to whether the capability will be rolled out across the entire Fire Scout fleet, Smith said: 'The current radar integration efforts are focused on limited number of MQ-8B air vehicles, with the plan to outfit all the MQ-8C air vehicles. The final acquisition strategy for integrating a radar capability on the MQ-8C air vehicle is still in development at this time.'

With the extended range, payload and cargo hauling capabilities of the Bell 407 helicopter, the MQ-8C Fire Scout is the largest VTOL UAV currently in development. The aircraft has the ability to autonomously take-off and land on any aviation-capable US warship and at prepared and unprepared landing zones, to provide reconnaissance, surveillance and target acquisition capabilities to naval commanders via its sensor suite, while also offering the flexibility of a 1,200kg external cargo sling, a maximum endurance of 14 hours and an operational ceiling of 17,000ft.

A total of 19 aircraft are under contract with the USN. Land-based flights began in October 2013 to validate capabilities, and in May the system was tested for its ability to operate safely in the intense electromagnetic environment aboard USN ships. Ship-based flights are scheduled to begin during 2014.

MAKING MOVES

Outside the US, the biggest moves in the VTOL community are being made by systems developed by European companies; namely Saab's Skeldar and Schiebel's Camcopter.

Skeldar is a medium-range (mission radius >100km) system, able to hover for six hours while providing real-time information from its 40kg capacity payload to a control station or a remote video terminal. Its mission payload can include daylight and thermal gimbals, SAR, ground moving target indicator (GMTI), Saab's Electronic Surveillance Payload (ESP), AIS transponder, searchlight/megaphone and a cargo hook.

In 2013, Skeldar was selected for a six-month trial by the Spanish Navy and deployed to the Gulf of Aden aboard the offshore patrol vessel *Meteoro* as part of the EU's Operation *Atalanta* (see p32).

According to Saab, trials such as this are an important aspect of helping customers to understand the best way to maximise the value of unmanned operations.

'The maritime customer has started to realise that you should use UAVs as a complement to manned aircraft, rather than looking at UAVs as a replacement for manned aircraft,' Anders Wennström, director of marketing at Saab, told *Unmanned Vehicles*. 'A UAV should be used for missions such as tracking and identifying targets – is that vessel a fishing boat or a pirate? Then, if it is a threat, you send in the manned aircraft to do the difficult work.'

Wennström said that Saab is not limiting itself to pursuing the maritime market, as Skeldar also has applicability to a range of land domain missions.

'When we first started with Skeldar the market was absolutely 100% in the land domain, driven by the need for convoy IED detection and protection for vehicles,' he said. 'Then it shifted over to maritime because of the piracy threat, and now I would say it is starting to shift back to land again.

'Because again, here in the land domain, customers are starting to understand the complementary application of UAV systems to manned aircraft – why send a manned helicopter to inspect a collapsed nuclear reactor where there are high radiation levels? Why send a manned aircraft to patrol and inspect borders for hours on end? When you start to see the potential, you can see the real benefit of the technology.'

CRACKING THE MARKET

Schiebel has been busy demonstrating Camcopter S-100 to potential customers as it looks to gain a footing in a maritime market currently dominated by the Insitu ScanEagle fixed-wing UAV. The company has recently ➤

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supported a Brazilian Navy trial of Camcopter for a possible future programme – for which it is competing against ScanEagle – and currently has aircraft operating on board an Italian Navy vessel in the Mediterranean as the service undertakes a complex procurement process and gains an understanding of what capabilities the system can deliver.

Schiebel believes that while ScanEagle manages to defeat the majority of the competition in the maritime domain with its 24+ hour endurance, the benefit of Camcopter's 50kg payload far outweighs that offered by ScanEagle's 4kg capacity, which generally limits options to a single EO camera.

'For the Brazilian Navy, we demonstrated three payloads – EO camera, radar and ESM – over a period of days, and showed them that they can get a far better capability than a single EO camera payload within the same footprint,' Chris Day, head of capability engineering at Schiebel, told *UV*. 'We understand that as a result of our demonstration they are now looking at some of their requirements because it is clear that they can get a lot more than they were expecting, and we await the formal RfP.'

The step-by-step process of the Italian Navy, Day believes, is typical of naval UAV acquisition programmes in a technology area mired by misinformation. For organisations that have a general knowledge but lack the details, this can slow the uptake of systems considerably, and it takes a fair amount of support from manufacturers to educate potential customers about the benefits.

'Navies, where VTOL has a clear advantage, also tend to be quite late adopters of new technology – compared to armies, which adopt early, but have generally stuck with fixed-wing solutions,' Day said. 'There's a saying that unless an admiral has had experience of a technology in his early career it won't be adopted or absorbed, but we're at the stage now where senior people will have had exposure to unmanned systems and are starting to see the value, and as a consequence there is starting to be a fair bit more interest.'

BEST OF BOTH

Any preference for fixed-wing or VTOL UAVs is always going to depend on mission requirements, with each type of system having its pros and cons. The overwhelming advantage of fixed-wing systems is endurance, but they require significant infrastructure and space for both launch and recovery – something that is not available in all operating scenarios.

On the other side of the coin, VTOL technology, while bringing the benefits of increased payloads and hover-and-stare capabilities, is much more complex and significantly more expensive to develop and procure.

One emerging innovation that aims to capture the best of both worlds is VTOL accessories for fixed-wing aircraft, such as the JUMP technology released by Arcturus UAV in April. This system allows the company's T-20 and T-16 fixed-wing aircraft to launch and recover vertically via a boom fitted with lift motors and rotors that can be mounted on each wing of the UAV. Once airborne, transition to fixed-wing flight is made by the autopilot, the vertical lift motors are shut off and the propellers are feathered longitudinally for minimum drag.

'In addition to tiltrotor technology, which is very mechanically complicated, in the rotary UAV world the very exciting and prolific technology is currently in quad-rotors, but they are generally one or two-hour endurance, whereas with the Jump 16 we get six hours and with Jump 20 we get nine to ten hours,' D'Milo Hallerberg, president of Arcturus UAV, told *UV*. 'So if you look at serious VTOL – we consider Camcopter as our closest competing product – it has serious endurance, six hours, but our solutions are one-tenth the cost of that system.'

The JUMP concept still has its limitations, but the company is working to increase flexibility all the time. Although it is unlikely to ever have the hover-and-stare capabilities of its more conventional rotary-wing counterparts, JUMP systems shipping by Q1 2015 will have onboard charging systems for the vertical motors that will give users the ability to stop and hover during flight for a 'small number of minutes'.

With it being a quad-rotor system, Hallerberg believes JUMP does have an advantage over the competition for shipboard launch and recovery.

'Shipboard recovery is always at the top of the need list for military customers as it is a very challenging issue – the most successful is ScanEagle, but it requires a heavy, expensive launcher and a separate piece of equipment for recovery, both assets that cost money, take up space on deck and require training to operate,' he said. 'The UAVs seriously making it work are Camcopter and Schiebel, but it is still very challenging.

'Take-off is no big deal, but landing is hard for a number of reasons, mainly because the superstructure of almost any ship that wants to carry a UAV shadows the landing area in the last 20ft. So vehicles come down in relatively good

Skeldar can hover for hours while providing real-time information to a control station or remote video terminal. *(Photo: Saab)*

An artist's conception of the MQ-8C Fire Scout's cargo-carrying capabilities. *(Image: Northrop Grumman)*

air, then hit turbulence, dirty air and changeable conditions in the last 20ft, meaning the aircraft needs as much agility and control authority as possible – something that is much greater in a quad-rotor device such as JUMP than in a single-rotor device.'

NEW ENTRIES

Beyond the major players in the VTOL sector, the market is flush with manufacturers introducing new systems – some of whom are beginning to chalk up modest sales.

One such new entry is the ASV-200 from Aero Surveillance, launched at Eurosatory in June. An evolution of the earlier ASV-150, with the ability to carry a 30kg payload for four hours at a time, the system has been developed for coastal and maritime patrol, infrastructure protection and border surveillance missions.

Philippe Roy, president and CEO of Aero Surveillance, told *UV* that the company was particularly responding to emerging requirements for naval VTOL capabilities in the sub-100kg category.

'We wanted to develop a system that essentially has 70-80% of the capabilities of Schiebel and Saab's machines, at half the weight and in a much less expensive package,' he said. 'Being a lighter package means we can deploy from much smaller vessels, such as those operated by coast guards – they want a system they can send out to check suspicious vessels in the vicinity and land back on the ship. You don't need a multi-million-Euro machine to do that.'

Roy said that the system, which also features a de-coupled payload and platform design for increased simplicity, has been sold for testing to a customer.

Elsewhere, LH Aviation (part of the Magellan Industries group) has acquired a multi-mission VTOL system from StationAir as part of plans to bring a line of UAVs – fixed- and rotary-wing – into its product portfolio.

The UAV is a 2.5m diameter, 16kg system with double counter-rotating rotors. Its kerosene-powered turbofan engine can propel the aircraft at up to 50kt during flights of up to 30km (up to 90 minutes) at a maximum altitude of 10,000ft. It can carry a payload of up to 15kg, and is controlled by a chest harness ground station.

Christophe Rémy, associate director at Magellan Industries, told *UV* that the company has secured its first contract with an unnamed customer in the civil security market, with deliveries due to commence in 2015.

He said the company is seeing 'more interest than it expected' in the UAV so far, and anticipates increasing demand from potential customers as it turns its focus to the military market, where users will be able to take advantage of the aircraft's flexible payload and capabilities.

'It will be suited to military users for a range of tasks thanks to its dual-use nature,' Rémy said. 'Depending on its payload, it can be used for LIDAR mapping, CBRN detection, aerial mapping or observation, and specific airdrop – it can also be used to deliver a smaller quad-rotor system for surveillance missions.'

The VTOL market is showing a range of interesting developments at this stage, and as greater maturity is exhibited by in-service systems, the uptake of the technology is only set to increase, bringing more capabilities to users in the maritime and land domains than ever before. **UV**

Offshore investment

As the threat of piracy remains a hot topic for navies and shipping companies around the world, **Matthew Smith** evaluates the role UAS can play in protecting vessels against such attacks.

The Skeldar VTOL system was deployed on counter-piracy operations with the Spanish Navy in 2013. *(Photo: Saab)*

An explosion of pirate activity, particularly around the Horn of Africa, at the start of the millennium saw multi-national military forces widely deployed in an effort to reduce attacks. Unmanned systems have been a key part of these deployments, with a number of different platforms having been involved in such operations.

Insitu's ScanEagle led the charge, and has been deployed with the USN since 2009 (perhaps the highest-profile case was the use of ScanEagle during that year's Maersk Alabama hijacking) and the Royal Netherlands Navy since 2012, but other manufacturers such as Saab and Schiebel have also sought to meet the emerging demand.

According to the International Maritime Bureau (IMB), counter-piracy operations conducted under the aegis of the EU Naval Force's (EUNAVFOR) Operation *Atalanta*, NATO and the multinational Combined Task Force 151, including those supported by UAS, have dramatically increased security in the Indian Ocean. The IMB's 2013 Piracy & Armed Robbery Report states that the number of actual and attempted attacks on ships is at its lowest level in five years, having dropped from a high point of 445 in 2010 to 264 in 2013. In April 2014, the ICC further reported the lowest level of attacks since 2007.

KEY CAPABILITY

Saab's Håkan Neckman explained to *Unmanned Vehicles* why unmanned systems are increasingly being seen as a key capability in counter-piracy operations.

'In principle, unmanned VTOL systems are utilised to expand the maritime surveillance area. They are capable of providing the mother ship with an airborne reconnaissance and surveillance capability more or less 24/7. The UAV can supplement an OPV's [offshore patrol vessel's] manned helicopter or, if none is carried, provide an extended surveillance capability which can extend the range and considerably enhance a patrol ship's effectiveness,' he said.

Matt Parker, director of UAS operations at UAV services firm Precision Integrated Programs, concurs with this assessment. 'In an area where there is a risk of pirate activity, it is good to have eyes in the sky to coordinate the situation and generate situational awareness. Beyond that, being able to see something before it happens, to be able to notify boat captains in the area of impending danger so that they can take proper precautions, can help prevent escalation of dangerous situations,' he told *UV*.

While naval UAV operations are clearly nothing especially new, the number of countries taking advantage of the capability appears to be on the rise.

The Spanish Navy trialled Saab's Skeldar V-200 rotary-wing UAS in 2013 and expects to acquire a similar system (although not necessarily Skeldar) in the future. In February 2014, it was announced that the Schiebel S-100 Camcopter was due to be deployed on a 12-month lease by the Italian Navy for anti-piracy missions. According to the company, the aircraft has already been used by the navies of Brazil, France, Germany, India, Italy, Pakistan and Spain, as well as the Dutch Coastguard.

Another potentially significant requirement is with the Brazilian Navy, which is seeking a small UAV to provide support to its *Amazonas*-class OPVs. In June, Schiebel said the Camcopter had undergone a four-day evaluation with the service. A company spokesperson confirmed to *UV* that the counter-piracy application was of interest to the Brazilian Navy during the trials.

FIRST IMPRESSIONS

The UK government also announced on 22 June that it had conducted the first flight of a ScanEagle installed on HMS *Somerset*. According to the MoD, this is the first time the UK has fielded a UAS on maritime operations.

Underlining the growing perception that naval UAS provide a key capability, Cdr Mike Smith, commanding officer of HMS *Somerset*, said: 'The system's arrival will fundamentally change the way we operate, making HMS *Somerset* more effective right across the diverse range of operational roles we can perform, be that counter-piracy, counter-narcotics, disaster-relief or warfighting.'

Meanwhile, Neckman offered an insight into how his company is looking to meet evolving maritime requirements, describing Saab's experience with the Spanish Navy.

In service with several navies, ScanEagle is considered a mature maritime solution. *(Photo: USN)*

In November 2013, the OPV ESPS *Meteoro* embarked a Skeldar V-200 for use on Operation *Atalanta*. This was the first time a UAV had been flown from a Spanish warship.

'The Spanish Navy wished to have both the practical experience of operating a VTOL UAV system on board and judge the contribution of abilities for an upcoming acquisition,' Neckman said.

'After a quick procurement, a contract was signed between Saab and the Spanish Navy. The contract included turnkey services where Saab provided the Skeldar UAS, made all permanent ship installations, and handled transport and logistics of air vehicles and spares to the mission area. Saab also provided the personnel that operated the system,' he continued.

One aspect of the evaluation saw Skeldar tasked with reporting real-time details of pirate attacks or suspected activities both ashore and at sea so that a quick military response could be provided to ensure safe transit of all shipping to and through the region under observation.

COMMAND DECISION

A spokesman for the Spanish Navy explained to *UV* why it had decided to use an unmanned system for this mission.

'The decision was made to operate the UAV together with a manned helicopter to enhance the vessel's surveillance capabilities during its counter-piracy mission as part of the *Atalanta* operation,' he said.

'The sheer size of Operation *Atalanta's* scenario, and the requirement for deterrence in anticipation of possible pirate activities, turn air vehicles into an essential operational asset. UAVs or RPAS decisively contribute to relieve the effort of embarked helicopters without diminishing the required surveillance capability, and at lower costs,' he added.

The UAS also gives a vessel access to capabilities that can only otherwise be provided by a manned helicopter. 'The UAV can be used for surveillance, reconnaissance and aerial photography. Its real-time data and image transmission allows detailed surveys in precise areas,' said the spokesman.

Neckman explained how the Skeldar was integrated with the *Meteoro*: 'An air vehicle was placed in the hangar, and another one in a container on the aft deck. [GCS] consoles were placed in the combat management centre [CMC] and all flights where managed from this position. During missions the CO and the personnel in the CMC could follow the flight and see sensor data via large centrally placed LCD screens. Skeldar carried an EO sensor for recognition and a real-time imaging capability. The UAV could transmit pictures both of unknown ships and objects on the beach.'

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On board ESPS *Meteoro*, Skeldar operated alongside an S-70 Seahawk manned helicopter. *(Photo: EUNAVFOR)*

ROOM FOR MANOEUVRE

Navigating the small spaces on a naval ship with an embarked helicopter already in place was a challenge, but one which Neckman says was resolved fairly simply. 'On board *Meteoro* was also an S-70B Seahawk and the co-location worked very well. The Skeldar was placed in front of the Seahawk, in the hangar and then moved when the S-70 was flying – but this was very easy with snap-on wheels.'

Integration of the system was also aided by commonalities between the helicopter and UAV. 'The Skeldar uses the same fuel [JP-5] as the Seahawk and operates under the same VTOL flight procedures. The UAV complements the regular helicopter with endurance.'

There are a wide variety of small UAS suitable for maritime operations, both fixed- and rotary-wing. However, for Operation *Atalanta*, the decision to look at a rotary-wing solution was based on a number of factors.

'The rotary-wing design permits reduced speeds, more manoeuvrability or hovering capability over a given position. It can also approach areas while remaining difficult to detect, even with surveillance radars. All these features contribute to make many anti-piracy operations far easier and at lower cost,' the Spanish Navy spokesman told *UV*.

'Skeldar, like other UAVs, complements and enhances the surveillance carried out by other assets. The risk when inspecting suspicious vessels is significantly reduced, while the burden to aircrews is also softened,' he added.

While the navy was unwilling to go into details of the precise lessons learned from its experience of the Skeldar deployment, saying only that 'it goes without saying that UAVs are very valuable and versatile systems for this type of scenario', it is clear that it demonstrated sufficient utility to be worth making the capability a more permanent fixture.

'The Spanish Navy is definitely committed to employing UAVs on board its naval force. [It] intends to operate these systems from air-capable warships with ad-hoc equipment and personnel purposely embarked for specific missions. However, a decision on the final system has not been made yet,' a spokesman told *UV*.

For its part, Saab appeared satisfied that the deployment had achieved its goals, saying: 'The programme has given both the Spanish Navy and Saab a lot of valuable experience of operating a VTOL UAS from a NATO naval ship during an operational mission, and that was one of the major goals of the programme. Based on the experiences gained during the mission, Saab has proven that we can deliver ship-based Skeldar UAS operational services.'

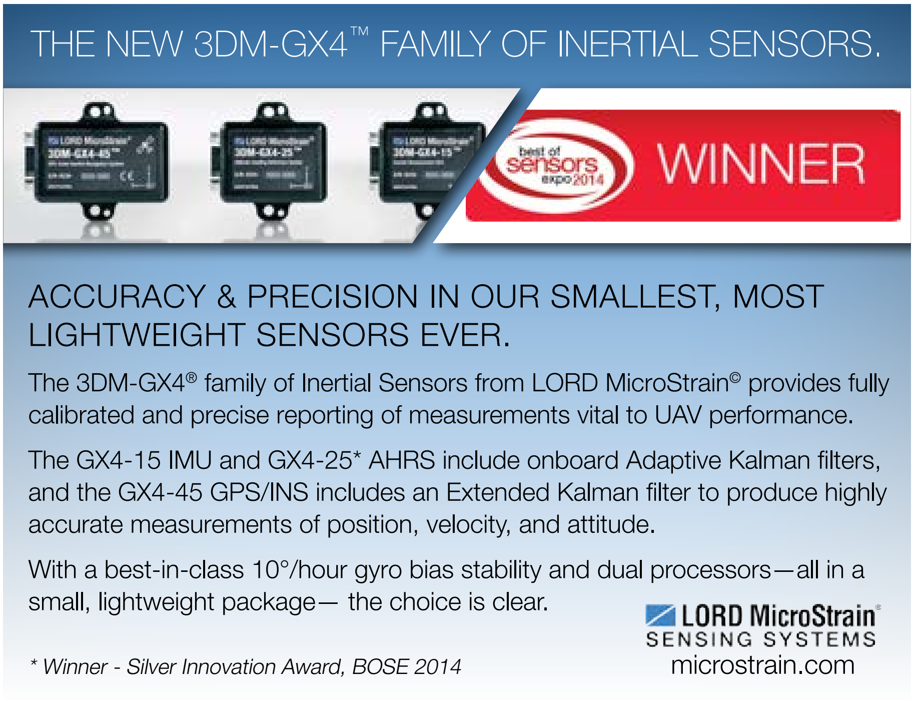
WIDER PERSPECTIVE

While the focus is currently on the tactical elements of UAS operations, there might even be potential for unmanned systems to provide a more strategic perspective, according to AeroVironment's Steve Gitlin. 'Global Observer is a [HALE] unmanned system we've been developing that could be a very useful tool for anti-piracy mission,' he said.

'It is designed to operate like an atmospheric satellite. It can fly for five to seven days and up to 55-65,000ft in a system that contains at least two aircraft, so that at any given time you have one circling over the Straits of Malacca, for example, or any area where there is pirate activity going on, providing real-time information and an unblinking eye for critical seafaring areas at a strategic level.'

Despite the progress being made in Africa, the piracy threat remains a real one, noted IMB director Pottengal Mukundan, who argued that there is no room for complacency, as it will take 'only one successful Somali hijacking for the business model to return'.

This is a view shared by Precision's Matt Parker: 'We have flown counter-piracy missions shipboard for the [US] DoD and that mission is



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still very important, despite the success and the victories that this technology has brought in mitigating the threat,' he told *UV*.

'Once you start making a couple of busts what you find is the pirates will try and change their tactics, or it becomes more of a deterrent to piracy activity. But the fundamental economic drivers of piracy are very difficult to address in the short term, so there is a continued need operate in this space.'

However, in the potential absence of a military force in pirate-infested areas in the future, the use of UAS on commercial vessels is also an area a number of companies are exploring.

'It has become common to use small armed groups on board merchant vessels as a standard operating procedure. A UAV system may replace this function by monitoring the immediate area, identifying hazardous activities, and with this in mind, providing the commanding officer with decision support for necessary measures,' said a Saab spokesperson.

One of the benefits of UAS for commercial shipping is that, according to the manufacturers, they have a small deck footprint, are simple to use and do not necessarily require the engagement of external contractors to operate.

Saab told *UV* that 'Skeldar for example, only needs a landing area of 30x30ft. The system is designed to be easy to operate. This means that the ship's ordinary crew can operate the system after short complementary training and eliminate the need of having additional UAV crew on board.'

LACK OF INCENTIVE

Parker is less convinced, however, that the economic realities of commercial shipping lend themselves to UAV operations.

'When we went to approach that market, the companies we spoke to told us there was no incentive to invest in a UAV capability compared to, for example, armed guards. Insurance companies will offer discount rates on premiums so that the presence of guards effectively pays for itself through those savings. That same discount is not available for adding a UAV.'

The Italian Navy is the latest maritime customer for Schiebel's S-100 Camcopter VTOL UAS. *(Photo: Schiebel)*

While there may not be much need for counter-piracy capabilities among commercial shipping firms, the experience Precision has gained operating in these areas has opened other civil opportunities, Parker says.

'We have done maritime protection for NGOs in Costa Rica looking for illegal fishermen coming in. We had success there because our UAVs not only spot illegal fishing, but provide evidence to support prosecution. We see that as a growth market that came out of our operations in the counter-piracy environment. Another area would be regulating fisheries in the Pacific,' he explained.

It is evident that as unmanned technology becomes more widely available, it is driving an expansion in the number of companies offering UAV capabilities for areas like counter-piracy, from small, cheap systems to higher-end, more capable platforms.

'What you're seeing in the industry is a preponderance of guys coming out and saying they have UAV experience, particularly in the anti-poaching and counter-piracy roles,' Parker considered.

'While we've been talking to government-level customers – the DoD, SOCOM – they've been talking to tech investors, getting money to enter the market, albeit at a level that's different to where Precision operates.'

However, this type of segmentation and competition is good for everyone, he concluded: 'The market will prove itself out – just like now there are people who drive Hyundai and there are people who drive Aston Martins. It's better for the industry as a whole that there is competition – the more people that are running after business, the better it is for everybody.' UV

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Russian robots

Oleg Martyanov, member of the State Military-Industrial Commission of the Russian Federation and head of the Laboratory of Combat Robotics, speaks to Eugene Gerden about some of the country's plans within the field of robotics.

With the appointment of Sergei Shoigu as Russian Minister of Defence in 2012, the country's army has started to pay more attention to its future, with robotic systems of differing classes due to play an ever-increasing role in operations.

In contrast to the past, when the most advanced Russian developments in the field of robotics were limited to basic UAV or underwater systems, the Russian MoD announced its intention on 8 July to develop new breakthrough combat equipment, which will be based upon robotic technologies aimed at significantly improving the efficiency of the warfighter.

The design of the new complexes has already started on the site of the Chief Research and Testing Center of Robotics (CRTCR), which was recently established within the former Air Force Engineering Academy in Moscow.

CURRENT PROJECTS

As head of the Laboratory of Combat Robotics – a research team that has been involved in the development of innovative combat equipment for the Russian Army and which is part of the CRTCR – Martyanov elaborated on the current robotics projects.

'The MoD has highlighted systems including autonomous landing platforms, anti-mine UGVs and robots for the search and rescue and medical evacuation of wounded personnel from the battlefield,' he said. 'Tests of some [areas of interest] have already been started. One such robot is known as Platform-M, and its tests took place during recent military exercises by the Russian Army in the Kaliningrad region.

'Platform-M is a small remote-controlled tracked vehicle which is equipped with four rocket launchers and a Kalashnikov machine gun. Tests of the Platform-M proved its high efficiency in the conduct of battles in urban areas and strikes against stationary and moving targets.'

SABOTAGE GROUPS

Elsewhere, he described another effort designed by the Serpukhov Military Institute, which is part of the Military Academy of Strategic Missile Forces, one of Russia's leading defence academies.

'This is a mobile strike/intelligence robotic system, which is used in conjunction with Typhoon-M, [a mine-resistant, ambush-protected armoured vehicle produced in Russia] and UAVs. It will specialise in the detection and liquidation of sabotage-reconnaissance groups.

'There are also plans for designing special robotics [systems] which will be used to equip the GAZ Tigr – a 4x4, multipurpose, all-terrain infantry mobility vehicle – and will have the ability to deal with tank attacks.'

Martyanov also outlined plans to design amphibious robotic systems as well as unmanned ground combat vehicles, with the latter being 'fully autonomous, providing an opportunity for the commander to operate it from long distances'.

However, Russian efforts are not just focused on the army. Martyanov explained that the MoD is planning to start supplying the navy with robotic guided missile systems by 2018.

'These kinds of robotics will have the ability to hit enemy targets in the air, underwater and even in outer space,' he continued. 'At the same time, there are also plans to develop a robotic platform for the marines.

'In addition, part of our plans is the design of robotics based on the avatar principle. These types of robots will be adaptable to human behaviour and very sensitive to their operator. Finally, during the next several years we plan to complete the development of special autonomous unmanned reconnaissance submarines.'

The Russian MoD has tentatively revealed it is looking to achieve an initial operating capability for such systems by 2018, although Martyanov admitted: 'The main thing is to develop and test all the necessary technologies of information transfer, signal control and response.

'By this time, we are also planning to complete the development of robot evacuators, which will be one of our most important developments. These will have the ability to detect, identify and evacuate wounded soldiers from the battlefield, as well as move on different types of terrain and soil. Such robotics complexes will be adapted to work with all the wounded, including those who are seriously [injured],' he concluded. UV

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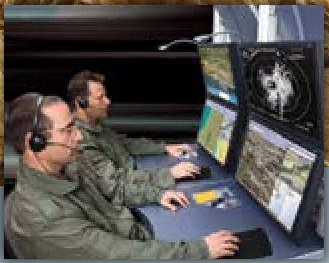

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